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of eyes: simple ocellus, compound ocellus (larval insects), aggregate (Isopoda) and compound eye. A brief description of each is given. Discarding all previous theories of vision by compound eyes, it is held that "a continuous picture, a mosaic of erect magnified central portions of the several subcorneal images, falls upon the retina."——Kraepelin (*Ueber die geruchsorgane der Gliederthiere*), *Osterprogram der Realschule des Johanneums, Hamburg*, 1883, gives an historical sketch of the olfactory organs of Arthropods, followed by a bibliographic list (59 numbers) grouped according to the languages in which the articles were written. He criticises the results of others, and compares them with his own observations on several crustacea, beetles, chrysopa, Orthoptera, butterflies, flies and Hymenoptera (*Psyche*, 296).——In the *Annales des Sciences Naturelles* (xvii, Nos. 5 et 6) is an interesting article by J. H. Fabre on the division of the sexes in the Hymenoptera; it gives the results of many years observations on the subject which we refer to more at length elsewhere.——The *Transactions of the American Entomological Society* (xii, No. 2) contain several papers by Dr. Horn, viz: Descriptions of new North American Scarabaeidæ; Contributions to the Coleopterology of the United States; Descriptions of new Cerambycidæ, with notes; Synopsis of the Throscidæ of the United States; while Mr. F. Blanchard discusses the species of *Canthon* and *Phanæus* of the United States, adding notes on other genera; and Mr. W. H. Ashmead remarks on the cynipidous galls of Florida, giving descriptions of new species.

ZOOLOGY.

LIVING AND DEAD PROTOPLASM.—Dr. Oscar Loew read an important paper before the British Association on a chemical difference between living and dead protoplasm. Protoplasm, it was found, contains certain aldehyde groups, which account for the extreme mobility and readiness of change in living protoplasm. These aldehyde groups can be reduced by alkaline silver solution. *Spirogyra*, one of the lower algæ, acts on this solution in a peculiar way. Living protoplasm reduces the salt, while dead protoplasm does not. The specific gravity of the protoplasm of *Spirogyra* was increased, and was found to contain silver deposited in its interior. *Argyria*, or the effect of nitrate of silver on the human subject in certain diseases, was found in these algæ. Thus was shown a specific chemical difference between living and dead protoplasm. Ordinary poisons, such as prussic acid and strychnine, seem to have no particular effect on lower organisms, while the poison irresistible by all protoplasm is hydroxylamyl. Professor Burdon-Sanderson said that this investigation had more importance than might at first appear, for it had arisen out of the epoch-making paper of Pflüger. Pflüger concluded that there must be a chemical change in the transition from living to dead

protoplasm, and Dr. Loew took up the question as to what exactly this change was. His investigations are an important step in deciding this important question. Professor Stirling said this gave a new test for living protoplasm. The chief thing to settle was what exactly causes reduction of the silver.

SPHÆRULARIA IN AMERICA.—In 1836 Léon Dufour described (*Annales des Sciences Naturelles*, ser. 2, v. 7, p. 9), a peculiar vermiform parasite, which he found in *Bombus terrestris* and *B. hortorum*, to which he gave the name of *Sphærularia bombi*, placing his new genus among the entozoa. In noting the occurrence of this genus of parasites in America, it may not be out of place to give some further account of it because of its unique structure and metamorphoses, and to enable its easy recognition.

Dufour's description reads: "Teres, albido-pellucida, mollis, filiformis, haud annulata, undique sphæculis vesiculæ formibus granulata, antero posticeque obtusa subrotundata." He adds in the French notes which accompany the above description that the length is 6–8 lines, that it is not very slim since it is about a line in diameter, that it shows no distinction of head or tail, being obtuse or rounded at both ends, and that all the surface, both above and below, is covered with spheroidal granulations which are like subdiaphanous vesicles.

Von Siebold, in 1838, wrote of this worm, and mentioned finding its young in bees, and that the young differed greatly from the supposed adult in having smooth skin. From the active young he saw that the worm belonged to the nematoids, but in the supposed adults, which were all females, he could discover no motion. He further notices that its digestive apparatus differs from that of all nematoids.

Siebold and Stannius write, "One finds neither mouth nor anus in *Sphærularia bombi*, and the intestinal canal is replaced by a series of elongated cells, adhering together, and around which the genital organs are entwined."

The next naturalist to investigate this curious animal was Lubbock, who published, in 1861, in the *Natural History Review*, a paper "On *Sphærularia bombi*," illustrated by a plate. Lubbock discovered at one end of the body which Dufour had described a minute nematoid worm, and wrongly thought this minute worm to be the male in copulation with the large body which was the female. In describing the so-called male, he is careful to state that he had not been able to distinguish any generative organs or any trace of spermatozoa, and discusses the possibility of the appended worm being a parasite of *Sphærularia*, or even its larval skin. Lubbock, whose article is very interesting, describes the anatomy of the so-called female, and states that it has "no muscles, no nervous or circulatory systems, and no intestinal canal," and that "the interior of the body is wholly occupied by

two relatively enormous organs—the double series of secretory cells, and the ovary.” The double series of cells he terms the *corpus adiposum*, and homologizes it with the intestine of other nematoids. Lubbock mentions briefly the prolificacy of *Sphærularia*, and the mode of development of its eggs. He discovered that the parasite was only present in large females of *Bombus*, but he was unable to trace its metamorphosis, and to discover how the bees were infected.

In a later paper Lubbock gives a brief account of his further studies on *Sphærularia*. He succeeded in keeping the young alive several weeks in water, and suggests that the young pass from moist earth into the bees while the latter are going about in moss and damp grass. He found half-grown females of *Sphærularia*, but still always with the so-called male attached, and he calls attention to the peculiar cell-structure of the so-called females.

Schneider was led by the cell-structure of the so-called females, and by the organic union between them and the little worm at their end, a union at a point where the sexual opening should be, to express the opinion that the so-called female was the evaginated and full-grown ovary of the little worm to which it was attached. Schneider's opinion, derived from structure, awaited proof based on observation, and this has at last been furnished by Leuckart.

Leuckart, in a preliminary communication in the *Zoologischer Anzeiger* of this year traces the evagination of the genital organs of the female to form the appendage which was so long regarded to be the female itself, the subsequent growth of the appendage, and the origin and homological significance of its parts. This worm-like body may even lose the minute female from which it was originally an evagination even before its eggs are ripe.

Lubbock, in the paper already mentioned, and Linstow, in his “Compendium der Helminthologie,” enumerate the species of *Bombus* in which *Sphærularia bombi* has been found; the former author gives their relative abundance in different species of bees, and states that the number of *Sphærulariæ* usually present in a single bee is from four to eight, but in one specimen he obtained no less than thirty-four, the greater number of which were full-grown. In some European species of *Bombus* one-half the large females which have hibernated contain these parasites in May and June.

Wishing to see if *Sphærularia* was to be found in America, I examined ten specimens of *Bombus* taken on the 10th of June last, in Cambridge, Mass. The species of *Bombus* were not determined. Only two of the specimens were parasitized; in one was a single *Sphærularia*, in the other were two. The *Sphærularia* found single was 2.9 centimeters in length; each of the other specimens was a trifle shorter. Nothing seemed to indi-

cate that the specimens found in the American bees were other than *Sphærulearia bombi*, except that they were a trifle larger than the size usually given for that species. Dufour states the length of *S. bombi* to be from "6-8 lin.," Lubbock "nearly one inch," and Leuckart "1.5 cm." Further examination of females of determined species of bees, at the time when they come from their winter retreat, and more specimens are necessary to know whether *Sphærulearia* is as abundant here as it is in Europe, and whether the species is the same.—*George Dimmock.*

NOTES ON SOME EASTERN IOWA SNAILS.—During the past season I have taken several interesting species new to the vicinity of Davenport, Ia. Among them the *Gundlachia meekiana* Stimp., a shell not before reported from the West. The specimens are decidedly larger than Stimpson's types, and extremely variable—some of them agreeing exactly with the description and figures of the *G. stimsoniana* Smith and Prime, and plainly indicating the specific identity of the two forms. As Stimpson writes, the septum in the aperture of *Gundlachia* seems to be formed at the end of the first season's growth; but numbers of *these* limpets formed no plate, simply adding the second season's growth on the margin of former peristome, thus making a real *Ancylus* with black conical cap. Lily pads seem to be their favorite station. Each limpet eating an irregular area on the under side, but never perforating the leaf.

Numerous specimens of the *Pyrgula scalariformis* Wolf, unnoticed since the publication of the original description nearly twenty years ago, were found near the mouth of Rock river, a few miles below Davenport. The validity of this species has recently been questioned by Mr. R. E. Call, who refers it to *Pomatiopsis lapidaria* Say! The specimens taken leave no doubt concerning the position of these tiny snails in the genus *Pyrgula*—unless the anatomy show greater divergence from that type than the shell. Our Rock river specimens are smaller, stouter than typical fossil *scalariformis*, and more compactly coiled—never exhibiting the peripheral carina on upper whorls. The shorter forms remind one of the common rhomboidal variety of *Anculosa dissimilis* Say. These have been distributed by the writer to correspondents under the varietal name of *P. scalariformis mississippiensis*.

Observations on Mississippi river *Lioplax* tend to confirm the opinion of the late Jas. Lewis, that the eastern and western *Lioplax* are especially distinct. The foot in our specimens only slightly exceeds the shell in length, while Binney's figures (of the eastern form) represent it nearly double the length of shell.

My measurements were taken while the animal was in rapid motion—its greatest length being then attained.—*Harry A. Pilsbry.*

THE BATRACHIAN INTERCENTRUM.—The determination of the homologies of the segments of the vertebral centra of the rhachitomous and embolomorous batrachians is a question of importance in the history of the evolution of the three classes of land Vertebrata, the Batrachia, the Reptilia and the Mammalia. I have already made such determinations, but Professor Gaudry subsequently made different ones, and in this he is followed by the European palæontologists, especially by Fritsch in his *Fauna der Gaskohle der Permformation Böhmens*. I have reëxamined this question, and with the aid of new material I am able to reach further definite conclusions in the matter.

The facts which I have discovered are the following:

I. In the Pelycosauria the chevron bones form a continuum with the intercentrum¹ (hypocentrum Gaudry).

II. In the caudal vertebræ of Eryops also (Rhachitomi), the chevron bones form a continuum with the intercentrum.² I therefore believe the intercentra of Clepsydrops and of Eryops to be homologous parts.

III. In the caudal series of Cricotus³ (Embolomeri) the intercentra are as large as the centra, and except that they form a continuum with the chevron bones, resemble them, and take part with them in supporting the neural arch.

IV. In the dorsal region of Cricotus the neural arch loses its articulation with the intercentrum and stands exclusively on the centrum.⁴ The serial homologies of the centra and intercentra are readily traceable in this genus throughout the column.

In spite of these facts Dr. Fritsch and others regard the intercentrum of the Rhachitomi (hypocentrum of Gaudry) as the true centrum. His reasons for this course are the following:

I. In the caudal region of Sparagmites and Diplovertebron the neural arch stands on the intercentrum,⁵ so that it is easily mistaken for a centrum.

II. In the dorsal region in Chelydosaurus and Sphenosaurus, the neural arch stands above or on the intercentrum, while the centrum (pleurocentrum and hypocentrum pleurale) is reduced in dimensions.

III. It thus results that the small hypocentrum pleurale resembles the intercentrum of the Reptilia and certain Mammalia, rather than the centrum, to which it truly belongs.

I am of the opinion that the homological determinations of Gaudry and Fritsch, in this matter, are erroneous, and for the following reasons:

I. The neural arch being free may change its articulation from

¹ Proceedings Amer. Philosoph. Soc., 1878, p. 510.

² Loc. cit., 1880. Pal. Bulletin, No. 32, p. 15, Pl. III. fig. 5.

³ Loc. cit., 1878, p. 522.

⁴ Loc. cit., 1878 522, and 1884, p. 29. Dr. Fritsch has overlooked these references, and wrongly believes that the complete intercentra of Cricotus are confined to the caudal region.

⁵ Fauna der Gaskohle, Bd. II, Heft I, Pl. 50, fig. 14, 15-16.

centrum to intercentrum and *vice versa*, while the chevron bones being continua, cannot do so.

II. The neural arch actually does shift its position in *Cricotus*. In the posterior part of the caudal series it is principally on the intercentrum; in the dorsal region it is on the centrum.

From the preceding considerations I get the following important results:

I. The principal vertebral bodies in the *Sphenosauridæ*¹ (*Sphenosaurus* and *Chelydosaurus*), if Fritsch's descriptions be correct, are intercentra and not centra.

II. It is probable that the true centra become extinct in the batrachian descendants of this family, so that the solid vertebræ of such *Batrachia* are intercentra, and not centra.

III. The characters of *Cricotus* on the other hand point to the extinction or reduction of the intercentra as we find it in the pelycosaurian *Reptilia*, and point to the probability of the *Embolomeri* being ancestors of the *Reptilia*, as I have already suggested.²

IV. The *Sphenosauridæ* (which must also include *Sparagmites*) are intermediate between the *Rhachitomi* and the *Embolomeri*, resembling rather the latter in the completion of the true centrum, but resembling the former in the incompleteness of the intercentrum.

I note here that Dr. Credner³ does not understand why I should have overlooked the discovery of the rhachitinous structure of *Archegosaurus* by Von Meyer forty years ago. I think any one who examines Von Meyer's description and figures will find ample reason why one should not see the rhachitinous structure in them, without overstepping the bounds of scientific caution. And it is evident that European naturalists did not recognize this structure, as they make no mention of it during those forty years, although specimens of *Archegosaurus* are abundant; but rather frequently referred *Archegosaurus* to the *Labyrinthodontia*, which are described as having the vertebræ undivided.

I had hoped to have given before now engravings in quarto of these important forms, but the present U. S. Geological Survey having suspended my work, I am unable to do so.—*E. D. Cope*.

EMBRYOLOGY.⁴

THE DEVELOPMENT OF THE TOAD-FISH.—The development of the *Batrachidæ* is not well known, as will appear from some of the statements in systematic treatises. One author states that: "The young of some or all the species fasten themselves to rocks by means of an adhesive disk, which soon disappears."

It is the purpose of this notice to point out that the adhesive disk referred to above is of a wholly different nature and origin from that found in the lump-fishes and *Gobiesocidæ* in which such

¹ Cope. *NATURALIST*, 1885, p. 592.

² *AMERICAN NATURALIST*, 1884, p. 37.

³ Die *Stegocephalen* aus dem Plauenschen Grundes bei Dresden; *Zeitschr. Deutsches Geol. Gessellsch.*, Berlin, 1885, p. 721.

⁴ Edited by JOHN A. RYDER, Smithsonian Institution, Washington, D. C.